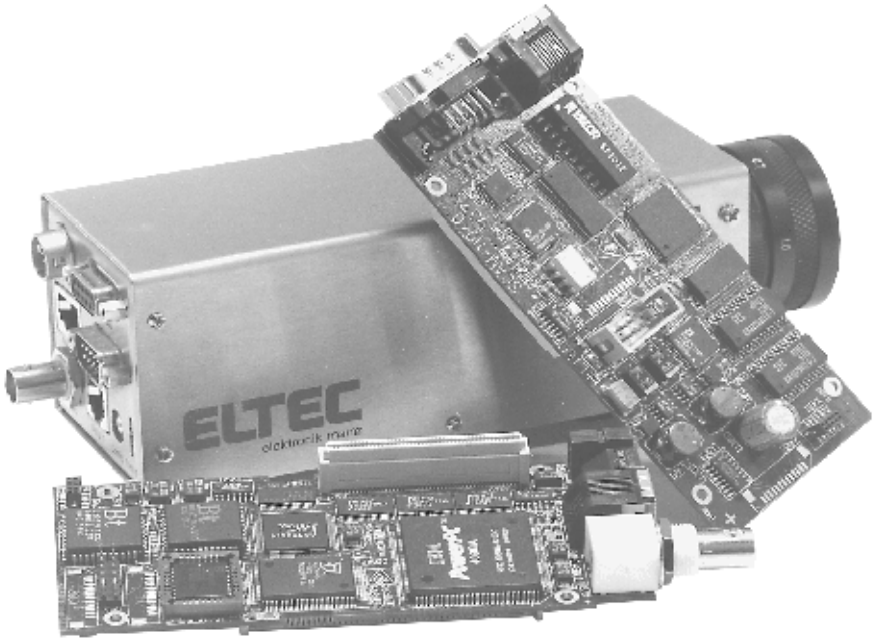
HiPerCam1

High Performance Camera



User's Manual

Revision 1 A

Revision History

Revision	Changes	Date
1 A	First Edition, valid for hardware revision 0A, 0B, 1A	16.05.97

WARNING !

This equipment generates and can radiate radio frequencies. If not installed in accordance with the instruction manual, it may cause interference to radio communications. The equipment has not been tested for compliance with the limits for class A computing devices, pursuant to subpart J of part 15 of FCC rules, which are designed to provide reasonable protection against such interference, but temporary usage is permitted as per regulations. Operation of this equipment in a residential area is likely to cause interference, in which case the user, at his own expense is required to take whatever measures may be required to shield the interference.

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Available Configurations

RAM	4 MB	8 MB	16 MB
CPU	PowerPC PPC 403 - 33/66 MHz		
Net	10 BaseT Ethernet		
Sensor	1/3" VCM3405 CCIR-625	1/3" VCM3405 EIA-525	
EPROM	1 MB Flash	2 MB Flash	

Related Products

Description:	Order No.:
Documentation	**V-HPC.-A991**
Hardware:	
Tripod Attachment Option, 2/3" thread for photo	**V-HPC1-Z001**
Power Supply Option, 230 V power outlet	**V-HPC1-Z002**
10BaseT Twisted-pair Network Cable, Crossover, for connection to host PC	**V-HPC1-Z003**
10BaseT Twisted-pair Cable, Standard, for Hub connection	**V-HPC1-Z004**
Serial Cable, 6-pin RJ12 to 9/25-pin (adapter included) D-Sub female, used for Serial 1 interface	**V-HPC1-Z005**
Serial Cable, 9-pin D-Sub female to 9/25-pin (adapter included) D-Sub female, used for Serial 2 interface	**V-HPC1-Z006**
Video Cable, 75 Ohm, BNC - BNC, 3 m	**V-HPC1-Z007**
Ethernet Hub, 8 10BaseT ports, AUI, Cheapernet	**V-HPC1-Z008**
Ethernet Card for PC, PCI	**V-HPC1-Z009**
Power Supply/US Version	**V-HPC1-Z010**
AUI Cable, 5 m	**V-CABL-A112**
Software:	
VxWorks Cross Development Package Tornado, with GNU C/C++, Win/NT for PC	**W-VXHC-A107**
HiPerCam1 BSP for Tornado with ELTEC Imaging API	**W-VXHC-A106**
VxWorks Runtime License for HiPerCam1	**W-VXHC-A101**

Conventions

If not otherwise specified, addresses are written in hexadecimal notation and identified by a leading dollar sign ("$").

Signal names preceded by a slash ("/"), indicate that this signal is either active low or that this signal becomes active with the trailing edge.

b	bit
B	byte
K	kilo, means the factor 400 in hex (1024 decimal)
M	mega, the multiplication with 100 000 in hex (1 048576 decimal)
MHz	1 000 000 Hertz

Indicates information that requires close attention.

Indicates critical information that is essential to read.

Indicates information that is imperative to read. Skipping this material, possibly causes damage to the system.

1 Specification

1.1 Main Features

- HiPerCam1: camera with built-in image processing computer.
- Smart camera complete with CCD, local CPU, and network connectivity.
- PowerPC processor with 30 ... 60 k Dhrystone, 40 ... 80 MIPS.
- Real-time acquisition of images directly into local memory for optimum CPU access.
- On-board ADC, input look-up table and DAC for video output.
- Complete interface equipment: two serial ports, Ethernet, digital I/O port, trigger input, video output.
- Basic software: VxWorks development system Tornado with GNU C/C++ compiler.
- ELTEC Imaging API.

1.2 General Description

HiPerCam1 is the first of a growing number of intelligent cameras from ELTEC. It is a complete CCD-based matrix camera with an intelligent frame grabber together in a small housing.

HiPerCam1 contains everything that is needed for image processing. A PowerPC CPU, peripherals optimized for embedded control applications, fast image and program memory, Flash EPROM, nonvolatile memory, video output, connectivity via Ethernet or RS-232, and our proven professional frame grabber logic.

On-board I/O is intended to communicate with an external computer through the serial connection as well as triggering flashlights with the parallel I/O bits. The Ethernet interface can transfer images or image processing results for remote display or is used for software download. The on-board DAC drives an analog video output, supplied for adjustment purposes; it shows the incoming analog video signal when acquisition is on or the stored images when acquisition is off.

Video input data is stored in main memory (RAM) via an on-board DMA controller. It can store video data at video rates in four possible formats each for CCIR-625 or EIA-525. Pixels are acquired synchronously to the camera clock. Smaller image fields (512 hor. e.g.) are centered, edges are left out.

The DMA controller is used to display live image or stored image data from local memory at the video output.

Video line pitch is the same as video line length to conserve memory - lines are tightly packed.

1.3 Mechanical Specification

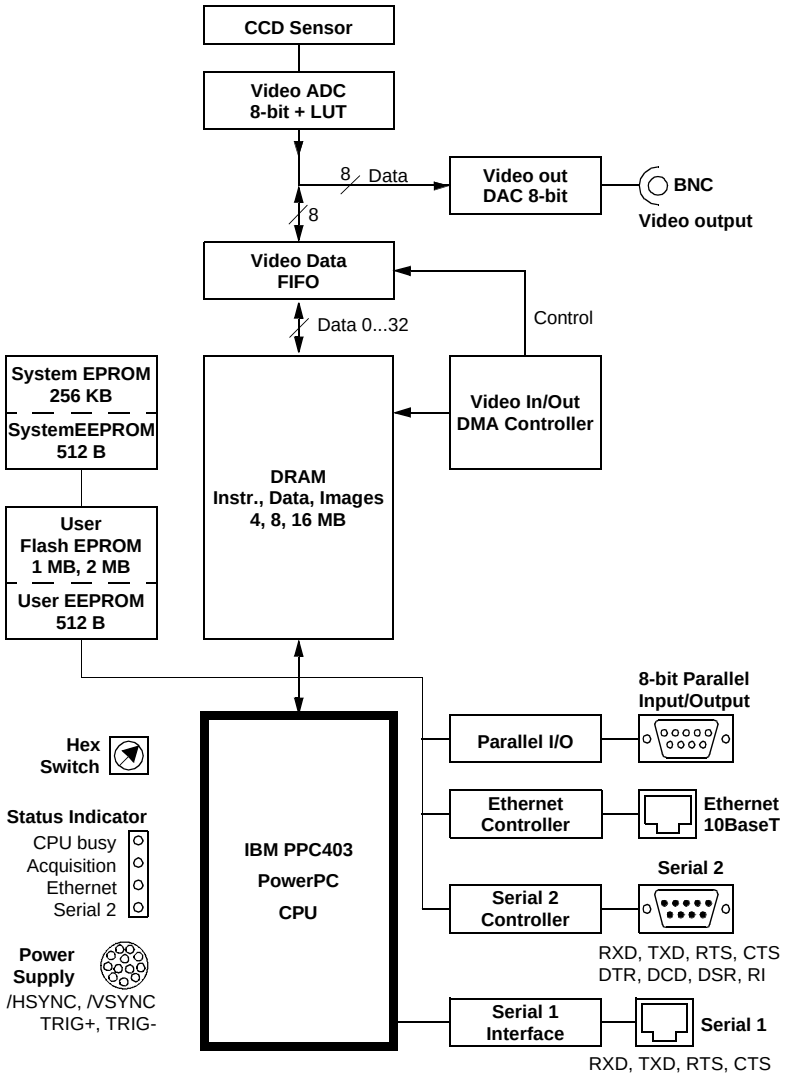
The HiPerCam1 case has a small cross-section of 60 mm x 60 mm and a length of 150 mm, making it possible to stack several HiPerCams in space-constrained applications. The camera has a C-mount thread for lenses; all electrical connections are routed to the HiPerCam1's back panel.

Table 1: HiPerCam1 Peripheral Connections

Connector	Connector Type	Signals	Data Rate
Digital I/O	9-pin D-Sub, female	8-bit TTL parallel I/O, I_{OH}= 3 mA, I_{OL}=10 mA	500 ns/IO
Serial I/O 1	RJ12	RS-232 serial (RXD, TXD, RTS, CTS)	300 bps ... 115 kbps
Serial I/O 2	9-pin D-Sub, male	RS-232 serial (RXD, TXD, RTS, CTS, DTR, DCD, DSR, RI)	
Power	Hirose 12-pin circular	+12V, trigger, video synchronization	-
Analog video output	BNC	Composite video signal 1 V_{PP}, CCIR-625/EIA-525	14.3 MPixel/s bandwidth
Ethernet	RJ45	10BaseT	10 Mbps
Lens	C-mount	n.a.	-
Status	-	CPU activity, acquisition, Ethernet, Serial 2	-

1.4 Technical Details

Figure 1: Block Diagram



1.4.1 CPU

The HiPerCam1 CPU chip is a member of the PowerPC family of RISC processors. It is a full PowerPC with on-chip peripherals optimized for embedded control.

Table 2: CPU

CPU	**IBM PowerPC 403 GA/GCX**
Compatibility	PowerPC family
Clock	33 MHz/66 MHz clock-doubled CPU opt.
Performance	40/80 MIPS
Power consumption	0.2 W/0.4 W
Caches	1K data, 2K instructions/8K data, 16K instr.
Data bus width	32

The PPC403 is a 32-bit RISC embedded controller with a specific implementation of the PowerPC architecture. The PPC403 consists of a highly pipelined processor core and several peripheral interface units as DMA controller, serial interface, asynchronous interrupt controller and programmable interval and watchdog timers.

1.4.2 DRAM Memory

The DRAM on the HiPerCam1 is used for data, instruction and video data. The memory is built by a standard 72-pin SO-DIMM. Memory sizes of 4, 8, and 16 MB are supported. The memory modules have to be 5 V types with 60 ns access time.

1.4.3 System Flash EPROM

The HiPerCam1 comes with a ROM-based firmware monitor for system initialization, basic debug, download and network configuration. This firmware monitor is held in the system EPROM. To come up with the system firmware, the hex switch on the back panel has to be switched to position '1'.

1.4.4 User Flash EPROM

The operating system together with user code can be programmed into the user Flash EPROM of the HiPerCam1. Monitor and debug kernel reside in the system EPROM, so there is no danger of corrupting vital system firmware while reprogramming the Flash EPROM. The user EPROM offers up to 2 MB program and data storage.

When the hex switch on the back panel is switched to any other odd position than '1', the HiPerCam1 comes up user-defined. Application can start image processing immediately after power-on or reset without any necessary download. So, the HiPerCam1 can be installed as a stand-alone image processing system.

1.4.5 Serial EEPROMs

On the HiPerCam1 two serial EEPROMs are available. One of these EEPROMs is used to store the system configuration and specific board parameters. The second EEPROM can be used by the user to store any data up to 512 B. To program the EEPROM, use special HiPerCam1 software functions.

1.4.6 Ethernet Interface

The 10BaseT Ethernet interface offers a communication link with high transfer rates and long distances (10 Mb/s, 100 m). So, the HiPerCam1 can be connected via Ethernet to a 10BaseT hub, which offers network links to other HiPerCams in the network and a host computer.

1.4.7 Serial I/O

The HiPerCam1 offers two serial interfaces Serial 1 and Serial 2. The Serial 1 interface is directly linked to the embedded PowerPC controller PPC403. This interface can be connected via a RJ12 jack on the back panel. Supported communication lines are Receive (RXD), Transmit (TXD), Request To Send (RTS) and Clear To Send (CTS). Software and hardware handshake is possible. Baud rates of 300 bps up to 115 kbps are supported.

The Serial 2 interface can be connected via a standard 9-pin D-Sub male connector on the back panel. This interface allows full RS-232 communication as necessary for modem support. Supported data lines are RXD, TXD, RTS, CTS, Data Terminal Ready (DTR), Data Set Ready (DSR), Data Carrier Detect (DCD) and Ring Indicator (RI).

1.4.8 Parallel I/O

On the back panel of the HiPerCam1 a 9-pin D-Sub female connector offers eight user configurable TTL I/O lines.

The port lines 0/1, 2/3, 4/5, 6/7 can be configured in pairs as input or output.

The parallel I/O is handled via specific library functions which offer input/ output configuration and port read/write operations.

1.5 Video Acquisition

1.5.1 Video A/D Converter

The video analog to digital converter is an 8-bit converter with a sampling rate up to 20 Msamples/s. The A/D converter also includes a 256 B x 8-bit look-up table (LUT). The LUT is applicable for signal correction and binarization. The look-up table can be initialized via a standard API function.

1.5.2 Video D/A Converter

The video D/A converter is used to display the live video data of the camera or the video data stored in the DRAM at a standard CCIR/EIA monitor. The maximum output voltage is 1 V_{PP} at 75 Ohm.

1.5.3 CCD Sensor

The HiPerCam1 is available with different built-in sensors: Modules for interlaced acquisition with optional square pixel format and restart are available. Features of the Philips VCM3405 include: programmable or auto gain, shutter speed 1/50 ... 1/12000 s, electronic iris with 1/2000 ... 1/100000 s exposure time, backlight compensation, gamma correction, non-interlaced operation, field/frame integration – all configurable by software. The electrical camera interface matches the sensor: a flash ADC with 14.3/12.5 Msamples/s is used for pixel-synchronous conversion; thus, subpixel computations are easy. Standard lenses are attached with a C-mount thread.

1.5.4 Video DMA Controller

The video DMA controller is used to store the incoming video data at video rates into the local memory. Four possible formats each for CCIR-625 and EIA-525 are implemented.

Table 3: CCIR-625 Formats

Dot clock MHz	Image Size	Format	Images stored in 4 / 8 / 16 MB without OS
14.3	768 x 568	CCIR full, double field	8 / 16 / 32
14.3	512 x 512	CCIR reduced, double field	15 / 30 / 60
14.3	768 x 284	CCIR full, single field	17 / 34 / 68
14.3	512 x 256	CCIR reduced, single field	30 / 60 / 120

Table 4: EIA-525 Formats

Dot clock MHz	Image Size	Format	Images stored in 4 / 8 / 16 MB without OS
14.3	768 x 480	EIA full, double field	10 / 20 / 40
14.3	512 x 480	EIA reduced, double field	16 / 32 / 64
14.3	768 x 240	EIA full, single field	21 / 42 / 84
14.3	512 x 240	EIA reduced, single field	32 / 64 / 128

While acquisition is active, the live image is displayed at the video output. The same DMA controller can also be used to display stored data at the video output.

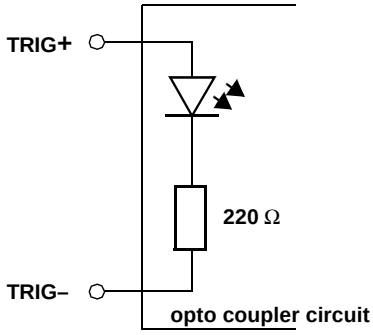
Either the video acquisition mode can be active - transferring video data from the CCD module to the local memory -, or the video display mode can be active - transferring video data from the local memory to the video output. Both modes can not operate simultaneously.

The base address to store the video image can be programmed into the video base address register in steps of 128 KB with API functions.

1.5.5 Trigger Input

The trigger input is opto-decoupled and occupies two pins on the 12-pin power connector. The two pins are connected to the anode and cathode of the LED in the opto coupler circuit (Figure 2: 'Opto Coupler Circuit'). Therefore, the external signal is totally independent of the internal signal level. An opto-decoupled trigger provides much better noise immunity than conventional TTL devices.

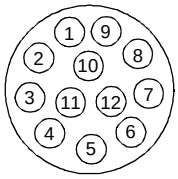
Figure 2: Opto Coupler Circuit



1.6 Connectors

Table 5: Power Connector (12-Pin Hirose Male Connector)

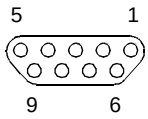
Pin	Signal
1	GND
2	+12V Power Supply
3	GND
4	NC
5	GND
6	/HSYNC input/output
7	/VSYNC input/output
8	TRIGGER input, TRIG–, max. 20 mA
9	TRIGGER input, TRIG+, max. 20 mA
10	NC
11	NC
12	GND
13	+12V Power Supply



Front View

Table 6: Parallel I/O Connector (9-Pin D-Sub, female)

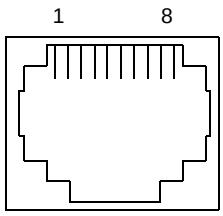
Pin	Signal
1	I/O Port bit 0
2	I/O Port bit 1
3	I/O Port bit 2
4	I/O Port bit 3
5	I/O Port bit 4
6	I/O Port bit 5
7	I/O Port bit 6
8	I/O Port bit 7
9	GND



Front View

Table 7: Ethernet Connector (RJ45 Jack)

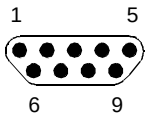
Pin	Signal
1	Transmit, TX+
2	Transmit, TX-
3	Receive, RX+
4	NC
5	NC
6	Receive, RX-
7	NC
8	NC



Front View

Table 8: Serial 2 Connector (9-Pin D-Sub, male)

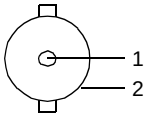
Pin	Signal
1	Data carrier detect, DCD
2	Receive data, RXD
3	Transmit data, TXD
4	Data terminal ready, DTR
5	GND
6	Data set ready, DSR
7	Request to send, RTS
8	Clear to send, CTS
9	Ring indicator, RI



Front View

Table 9: Video Output (BNC Connector)

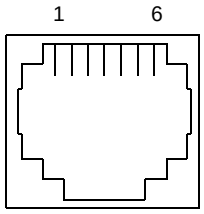
Pin	Signal
1	Video output
2	GND



Front View

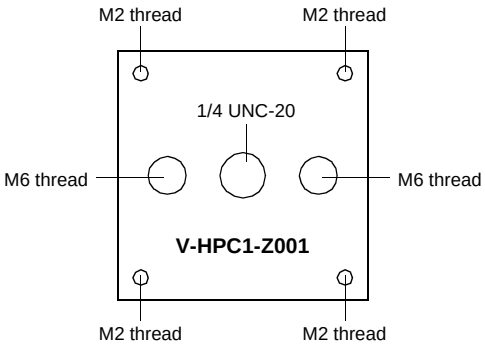
Table 10: Serial 1 Interface (RJ12 Jack)

Pin	Signal
1	Request to send, RTS
2	Transmit data, TXD
3	GND
4	GND
5	Receive data, RXD
6	Clear to send, CTS



Front View

Figure 3: Tripod Attachment



1.7 System Parameters

1.7.1 Environmental Conditions

- **Storage Temperature:**

  -25 °C to +85 °C

- **Operating Temperature:**

  0 °C to +45 °C (non condensing)

- **Maximum Operating Humidity:**

  85% relative

1.7.2 Power Requirements

- **Input voltage range 9 V ... 25 V DC (stabilized, ripple <10%)**
- **Typ. 550 mA at 12 V, max. 650 mA**
- **Typ. 6.6 W, max. 8 W**

1.7.3 Dimensions

- **60.8 mm x 60.8 mm x 150 mm (without lens, tripod attachment, protrusion of connectors at back panel)**
- **Weight:**

  approx. 650 g

1.7.4 Regulations/Compliance

- **CE**

1.7.5 Sensor

- **CCIR: 720 x 568 pixel**
- **EIA: 736 x 480 pixel**
- **Horizontal resolution (TV lines) 560**
- **CCIR vertical resolution (field integration mode, TV lines) 415**
- **CCIR vertical resolution (frame integration mode, TV lines) 485**

1.7.6 MTBF

- **7538 h (computed after MTL HDBK-217E)**
- **101009.2 h (realistic value from industry standard experience)**

2 Camera Control Functions

The on-board camera control logic hardware makes versatile camera features possible. These functions are discussed in this chapter. All functions are supported by API functions.

The Philips CCD sensor module offers several features which all can be controlled via ELTEC API function interface.

Synchronization

The 12-pin Hirose connector offers /HSYNC and /VSYNC signals for camera synchronization. These signals can be used as outputs of the internal camera timing or as inputs for synchronization from external sync source. Usage as input or output is selected via an API function. In case of external synchronization there are four possible modes:

The hardware can be damaged when /HSYNC, /VSYNC signals at the 12-pin Hirose connector are set to output and an external source also drives these signals. By default these signals are set to input.

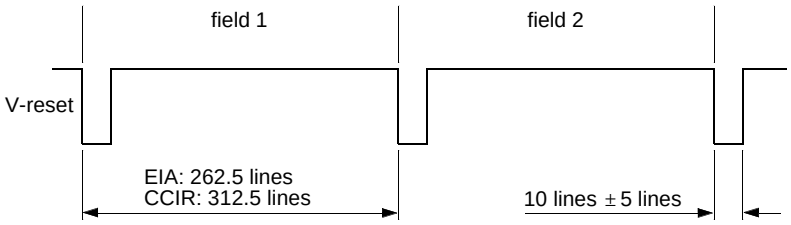
- **Reset/Restart**
  An external trigger impulse at TRIG+/TRIG- of the 12-pin Hirose connector leads to a camera Restart/Reset if the Restart/Reset feature is enabled by software.

  If the Restart feature is enabled, an external trigger signal restarts the camera (timing of the CCD module is reset) and starts the acquisition. So no frame delay occurs for triggered snapshots.

- **V- lock**
  In this mode the camera is synchronized in vertical direction. This mode is also called line lock.

  For this mode a negative V-reset pulse has to be applied to the camera via the /HSYNC input. The amplitude of the pulses that are supplied to the camera should has to be TTL-level.

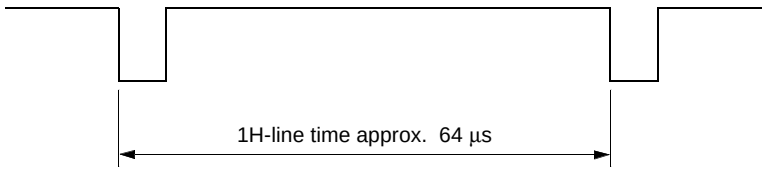
  The V-reset timing has to be as follows:



- **Synclock with V-reset**
  In this mode the camera can lock to a composite sync signal if also a V-reset is applied to the camera. The composite sync pulses have to be fed to the camera via the /HSYNC input, the V-reset pulses via the /VSYNC input.

  The amplitude of the pulses that are supplied to the camera have to be TTL.

  The composite pulse has to be a negative pulse as follows (vertical pulse components not shown):

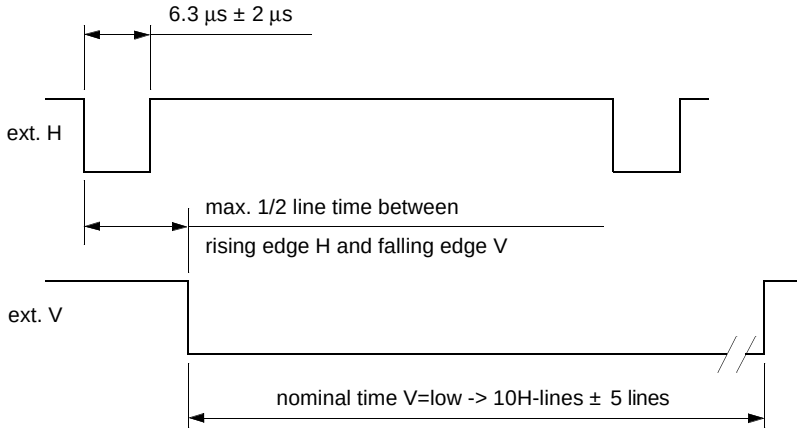


  For requirements of the V-reset signal, see description to mode V-lock.

• **H- and V-lock**

In this mode the camera is locked in vertical and horizontal direction to the external timing. The external HSYNC and VSYNC pulses have to be applied via the /HSYNC and /VSYNC inputs correspondingly. The amplitude of the pulses that are supplied to the camera has to be TTL. It is very important that the falling edge of the V-pulse comes within half a line after the falling edge of the H-pulse.

The external HSYNC and VSYNC timing parameters have to be as follows:



Shutter speed

The camera offers several integration modes. It is possible to select eight fixed shutter times. In the electronic exposure mode, an auto exposure circuit adapts the shutter speed to the brightness of the scene. This feature is intended for surveillance systems, while the fixed shutter mode meets requirements of industrial machine control. The following table shows the different shutter speeds:

Mode	Shutter Speeds
Fixed Shutter Mode	1/60 s (EIA), 1/50 s (CCIR)
	1/100 s (EIA), 1/120 s (CCIR)
	1/250 s
	1/500 s
	1/1000 s
	1/2000 s
	1/5000 s
	1/10000 s
Electrical Exposure Mode (electronic iris)	min ss: 1/100.000
	min ss: 1/39.000
	start ss: 1/100.000
	start ss: 1/2000

Field/Frame integration

In field integration mode every line is exposed 20 ms for CCIR and 16.6 ms for EIA. In field one the lines 1 and 2, 3 and 4, 5 and 6 etc. are added up and in field two the lines 2 and 3, 4 and 5, 6 and 7 etc. are added up. So each line is used twice, once in field one and once in field two. In field integration mode the vertical resolution is 415 TV lines (CCIR).

In frame integration mode every line is exposed 40 ms for CCIR (33.33 ms for EIA) In field one only the odd lines are coming out of the CCD. The even lines will be exposed for an extra 20 ms (16.6 ms). So after an extra field period the even lines are coming out. The vertical resolution in this mode is 485 TV lines (CCIR).

Line mode

Line mode is a special CCD-sensor mode. Line mode can be set to interlaced (normal operation mode) or noninterlaced. In the noninterlaced mode field one and field two are equal to each other. The lines 1 and 2, 3 and 4, 5 and 6 etc. are combined to build a single line.

In this mode the pixel arrays are rectangular and the vertical resolution is reduced to half.

Gamma correction

Gamma is a nonlinear function in the camera to compensate the nonlinear behavior of the monitor. Normal gamma coefficient is 0.45. For pattern recognition a linear behavior is often more useful, so the gamma correction can be switched off.

Backlight compensation

Backlight compensation can be quite useful if the main object of the scene is in front of a very bright background. So the main subject can become very dark and difficult to recognize. In normal mode the auto exposure control loop measures the average signal of the complete image. In backlight compensation mode only the bottom part of the scene is taken into account for the auto exposure control loop.

Gain

The camera has a gain control logic. So auto gain and fixed gain control is possible. Using auto gain the video output signal is kept at 1 V_{PP} over a certain illumination range. For normal gain mode the gain of the output can be individually adjusted by the user. Adjustment range is 0 ... +16 dB.

Double field/single field acquisition

With this feature a single field acquisition mode or a two field acquisition mode is selectable. The difference between the two modes is as follows:
For single field acquisition each field is in one frame.

In the double field acquisition mode, a frame consists of an even and an odd field. In the local memory the image is stored in linear which means after an even line follows an odd line and vice versa.

Field ordering

The field acquisition order can be set to even-odd ordering or can be set to don t care.

Acquisition window size

For CCIR a window size of 768 x 582 (full acquisition window, double field), 768 x 291 (full acquisition window, single field), 512 x 512 (reduced acquisition window, double field), 512 x 256 (reduced acquisition window, single field) is selectable. For EIA a window size of 768 x 492 (full acquisition window, double field), 768 x 246 (full acquisition window, single field), 512 x 480 (reduced acquisition window, double field), 512 x 240 (reduced acquisition window, single field) is selectable. The pitch size is 512 for a reduced acquisition window size and 768 for a full acquisition window size.

For window size of 768 pixels per line:
EIA sensor: 32 invalid pixels at each start of a line
CCIR sensor: 48 invalid pixels at each start of a line

Enable DMA function

This feature enables or disables the video DMA transfers. The DMA transfers have to be enabled to store image data into the memory or to display image data at the video output.

DMA transfer direction

The transfer direction of the video DMA transfers has to be set to display video data on the video output or to store the image data into the local memory.

It is either possible to display stored video data on the video output (DMA transfer direction is from local memory to video display unit) or to store incoming video data to the local memory (DMA transfer direction is from video acquisition unit to local memory). Both possibilities cannot be used simultaneously.
It is recommended to set the DMA direction only when no the DMA transfers are active (DMA transfers disabled) else video data could be corrupted.

Interrupt control

The HiPerCam1 offers video API function which displays the following status conditions:

- Acquisition running / No acquisition running
- Acquisition finished / No acquisition finished
- VSYNC active / VSYNC inactive
- Odd field active / Even field active

Video interrupts can be generated for the CPU on the following conditions:

- Interrupt triggered when acquisition is finished
- Interrupt triggered when VSYNC is active

The video interrupts are connected to interrupt line (/IRQ3) and critical interrupt input (/CINT) of the CPU.

2.1 Default Settings

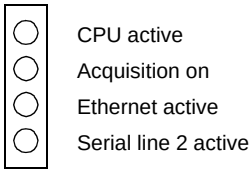
Table 11: Default Settings

Function	Default Setting
Acquisition window size	Reduced acquisition size
Two field/single field acquisition	Single field
Field ordering	even - odd
Enable DMA function	Disabled
DMA transfer direction	Acquisition into to memory
Interrupt control	Interrupt disabled
Line mode	Interlaced
Gamma correction	Off
Backlight compensation	Off
Gain	Minimal gain
Field/Frame integration	Field integration
Shutter speed	1/50 s CCIR; 1/60 s EIA
Synchronization	Internal Synchronization

2.2 Status Display

On the back panel of the HiPerCam1 four LEDs indicate the operating status of the HiPerCam1. The upper LED signals that the CPU is running. The LED below shows video acquisition activity. The next LED indicates transfers on the Ethernet interface and the LED at the bottom is flickering during transfers via the Serial 2 interface.

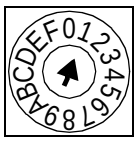
Figure 4: Status Display



2.3 Config-Switch

The hex switch on the back panel defines the configuration source and special operation modes. Switch position '1' is the default setting and forces the HiPerCam1 to come up with the system monitor of the system EPROM. All other non-reset positions are reserved for user specific configuration. In that case the HiPerCam1 uses the user Flash EPROM as boot ROM. As an example at time of delivery a stand-alone VxWorks OS is installed in the user Flash EPROM.

Figure 5: Hex Switch



All even switch positions (0, 2, 4, 6, 8, A, C, E) hold the HiPerCam1 in reset state.

3 Installation

3.1 First Steps

- Carefully remove the camera from the shipping carton.
- Save the original shipping container and packing material for storing or reshipping the camera.
- Inspect the camera for any shipping damage. If undamaged, the camera can be prepared for system installation.
- Make sure that the hex switch is in position 1.
- Connect the HiPerCam1 as shown in Figure 7, 8, 9.
  - Connect the serial 1 interface to your terminal/host.
  - Connect the HiPerCam1 via 10BaseT to your host.
- Configure the host and the HiPerCam1 as described in Section 3.3 "Software Configuration".

3.2 Connect the HiPerCam1 to the Host

To connect the HiPerCam1 to the host the serial 1 interface must be connected to an ASCII terminal or emulator. Otherwise no HiPerCam1 boot configuration is possible. Therefore use ELTEC serial cable V-HPC1-Z005. Also a network connection from the HiPerCam1 to the host system must be installed as shown in Figures 7, 8, 9 to allow boot file download.

The HiPerCam1 can be directly connected to the host via a special crossed 10BaseT network cable (ELTEC V-HPC1-Z003). So, no hub is necessary.

For power supply of the HiPerCam1 use ELTEC power supply V-HPC1-Z002 (US version: V-HPC1-Z010).

A video monitor should be connected to the HiPerCam1. After power-on a live image can be seen on the monitor.

Before starting the HiPerCam1 make sure that the configuration of the host and the HiPerCam1 is correct. Therefore refer to Section 3.3 'Software Configuration'.

Figure 6: Location of Switches and Connectors on the Back Panel

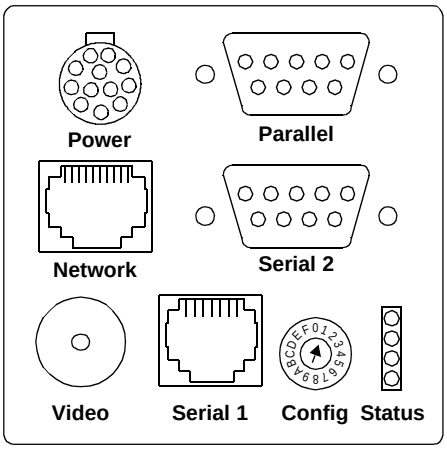


Figure 7: Connecting IHiPerCam1 to Host (without Hub)

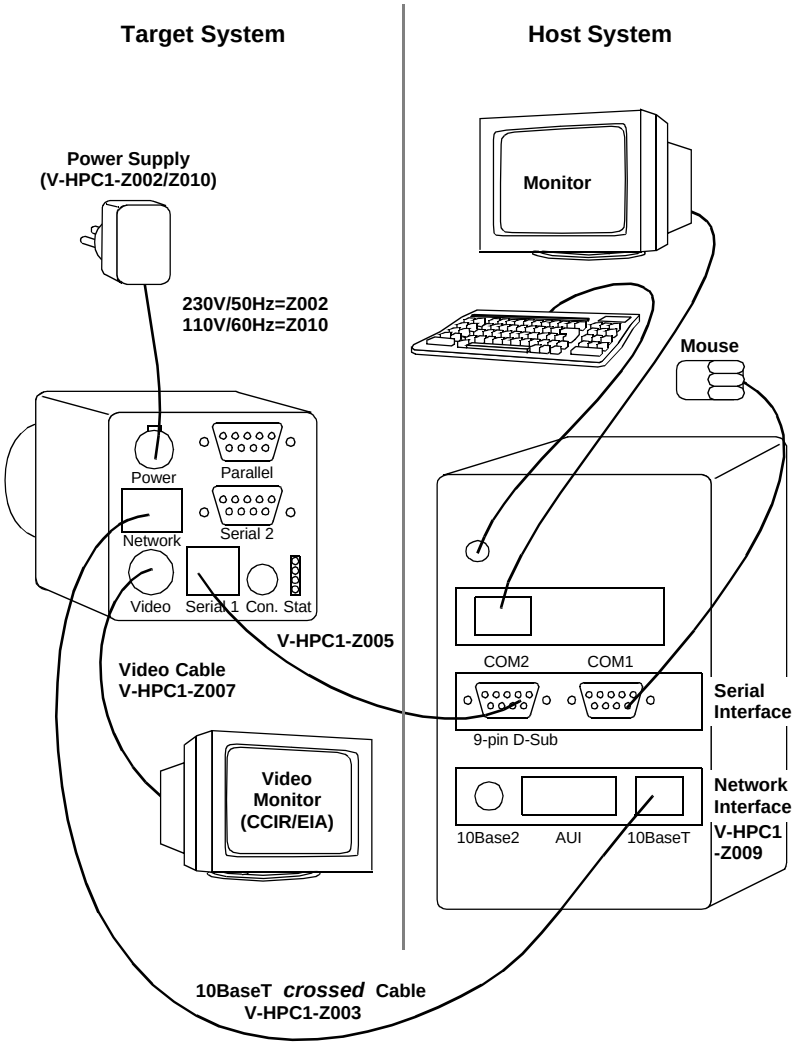


Figure 8: 10BaseT Hub Network Connection

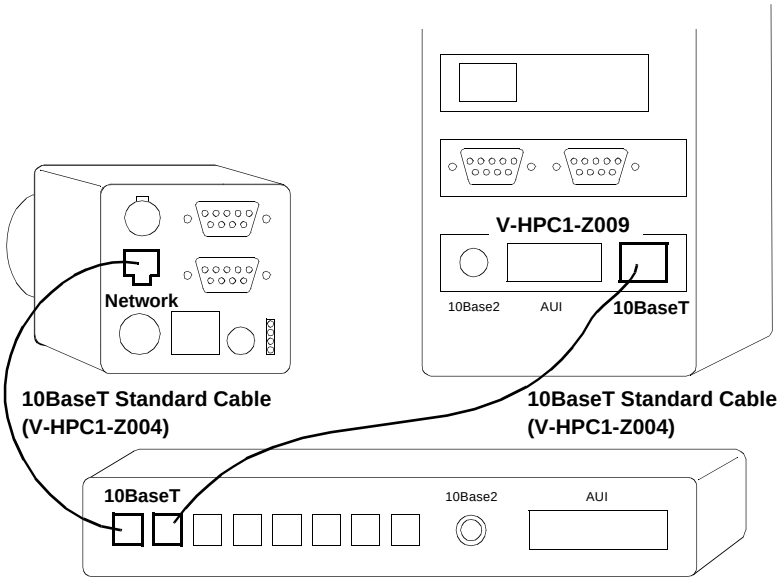
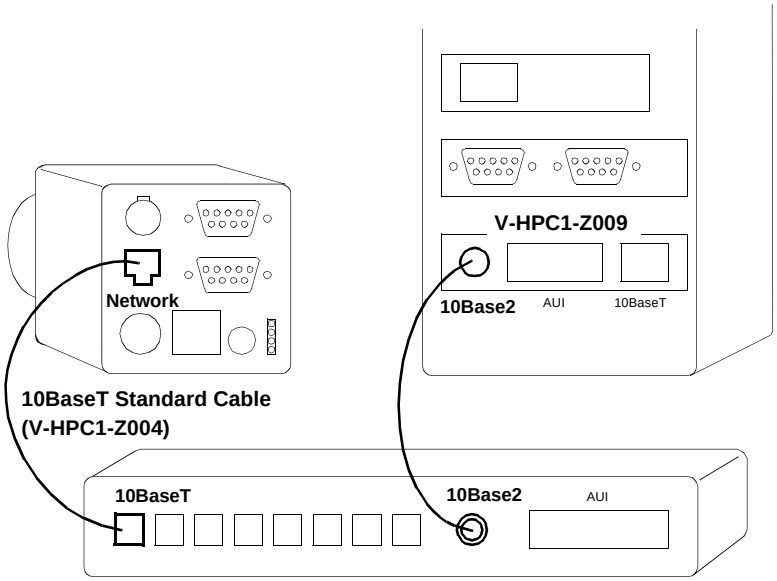
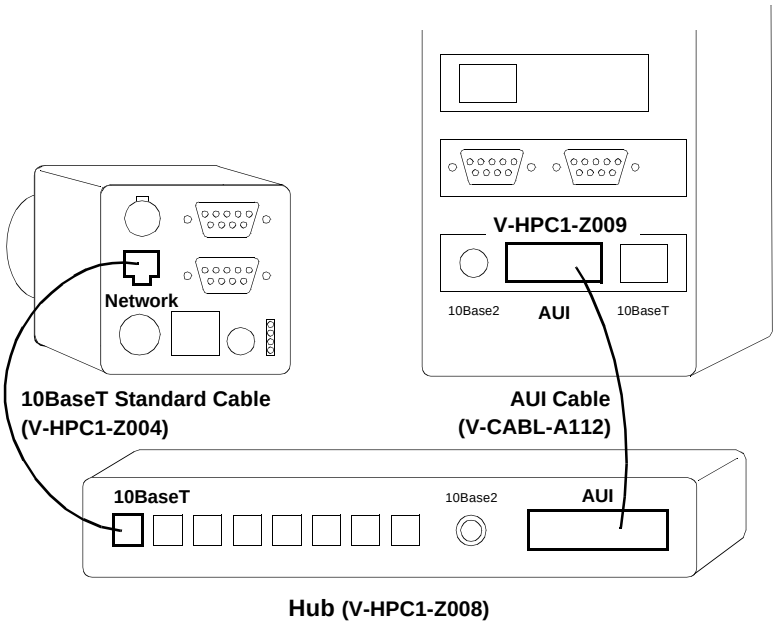


Figure 9: 10BaseT/10Base2 IHub Network Connection



Take care that the 10Base2 network connection is correctly terminated at both ends.

Figure 10: 10BaseT/AUI Hub Network Connection



3.3 Software Configuration

To become familiar with the HiPerCam1 family, the host and the HiPerCam1 should be configured for the first steps as described in this section. First the VxWorks Tornado cross development should be installed on the host (see Tornado User's Guide) with the BSP/API package supplied by ELTEC for the HiPerCam1.

3.3.1 Configuration of the HiPerCam1

If you have correctly configured your host software and target hardware, you are ready to turn on the target system power and boot VxWorks.

When you power on the HiPerCam1 (and each time you reset it), the HiPerCam1 starts from system EPROM (hex switch position 1). During the boot process, the camera uses its serial port to communicate with your terminal or the terminal emulation (default VT100) of the workstation. The boot program first displays the ROM BSP version, and then starts a seven-second countdown, visible on the screen. Unless you press any key on the keyboard within that seven-second period VxWorks boots automatically with a default configuration.

To change the boot configuration, first power on (or reset) the target; then stop the boot sequence by pressing any key during the countdown. The boot program displays the VxWorks boot prompt, as follows:

```
[VxWorks Boot]:
```

3.3.2 Entering Boot Parameters

Before booting VxWorks, you have to set the configuration parameters for the boot, including the host and target network addresses, the file to be booted, the user name, and so on.

The VxWorks boot program provides a limited set of commands. To see a list of available commands, type the help command (**h** or **?**) followed by <Enter>. For more detailed description of the commands, see the Wind River Systems Tornado User's Guide.

To display the current boot parameters, type '**p**' at the boot prompt, as follows:

```
[VxWorks Boot]: p
```

A display similar to the following appears; the meaning of each of these parameters is described in the next section. The '**p**' command does not actually display blank fields, although this example shows them for completeness.


```
boot device             : nicHPC
processor number        : 0
host name               : hpchost
file name   : /tornado/target/config/HiPerCam1/vxWorks
inet on ethernet (e)    : 195.0.0.201
inet on backplane (b)   :
host inet (h)           : 195.0.0.200
gateway inet (g)        :
user (u)                : HiPerCam1
ftp password (pw) (blank=use rsh) : 403
flags (f)               : 0x0
target name (tn)        :
startup script (s)      :
other (o)               :
```

To change the boot parameters, type '**c**' at the boot prompt:

```
[VxWorks Boot]: c
```

In response, the boot program prompts you for each parameter. If a particular field has the correct value already, press <Enter>. To clear a field, enter a period (.), then press <Enter>. If you want to quit before completing all the parameters, type <CTRL> + **D**.

Network information has to be entered to match your particular system configuration. The 'inet' addresses has to match those in your system's hosts file (or those known to your Domain Name Server), as described in the Wind River Systems Tornado User's Guide.

Necessarily the boot configuration parameters have to be changed corresponding to your system environment.

`host name`	The name of the host machine to boot from. This is the name by which the host is known to VxWorks; it need not be the name used by the host itself (hpchost).
`file name`	The full pathname of the VxWorks object module to be booted (/tornado/target/config/HiPerCam1/vxWorks). This pathname is also reported to the host when you start a target server, so that it can locate the host-resident image of VxWorks.
`inet on ethernet (e)`	The Internet address of the HiPerCam1 with an Ethernet interface (195.0.0.201).
`host inet (h)`	The Internet address of the host to boot from (195.0.0.200).
`user (u)`	The user name that VxWorks uses to access the host (HiPerCam1 in the example); that user must have permission to read the VxWorks boot-image file. VxWorks must have access to this user's FTP sign on, with the FTP password provided below.
`ftp password (pw)`	The 'user' password. This field is not required by the boot program, but you must supply it to boot over the network

from a Windows host. (If you do not supply this password, the boot ROM attempts to load the run-time system image using a protocol based on the UNIX `rsh` utility, which is not available for Windows hosts.)

The boot parameters are stored in the system EEPROM and retain even if power is turned off. For each subsequent power-on or system reset, the boot program uses these stored parameters for the automatic boot configuration.

3.3.3 Configuration of the Host System

The HiPerCam1 is connected to the host's system via an ethernet 10BaseT interface (shielded twisted-pair) and a serial interface. The serial interface is used as a terminal (default ASCII terminal configuration is 9600 bps, 8 data bits, no parity, one stop bit, protocol Xon/Xoff) connection to set the boot parameters on the HiPerCam1 as described in Section 3.3.2 'Entering Boot Parameters'. The network interface is mainly used for program downloads and data transfers between the host and the HiPerCam1.

3.3.4 Configuration of the Network Interface

The network interface of the host system has to support the TCP/IP protocol. Therefore it is necessary to add this protocol type into the network configuration setup. For correct message transfers, a network IP address has to be declared and a host name has to be defined for the host network interface. If these parts are done, make sure that the host IP address and the host name correspond to the entries specified in the HiPerCam1 boot parameter configuration (default setting: host IP address:195.0.0.200, host name: hpchost). Make sure that the user name is known to the host and has permission to access files in the specified directory.

3.3.5 Configuration of the Tornado Cross-Development

Tornado is the integrated environment for software cross-development for the HiPerCam1. The Tornado environment provides an efficient way to develop real-time and embedded applications. The following describes the basic environment configurations for getting started with the HiPerCam1. For more detailed descriptions, refer to the Tornado User's Guide. When installing the Tornado on the host system the VxWorks port mapper, the VxWorks registry and the VxWorks terminal emulation should be added in the autostart file.

These programs are mandatory for working with Tornado and HiPerCam1. Also an FTP server has to be started to allow network connectivity.

For Windows NT or UNIX the host system built-in FTP server has to be used. For configuration, refer to the Windows NT/UNIX system manual.

For Windows 95 systems the FTP server is included in the Tornado 1.0 Development Package and has to be configured as shown. This description refers to Tornado 1.0 and could be subject to change in the next version.

- Open the WFTPD window and select the Users/rights command from the security menu.
- Via the **New User** button a user name can be entered which has to correspond to that declared in the HiPerCam1 boot parameter configuration (default setting: hipercam1).
- A password has to be specified which has to correspond to that declared in the HiPerCam1 boot parameter configuration (default setting: 403).
- A home directory has to be defined in the home directory text box (useful setting: C:\).
- In the submenu **Rights >>** enter * in the **directory** text box.
- The configuration is saved by clicking the button **done**.

To display network messages during the boot procedure set **enable logging** in the **Logging LogOptions** menu.

Now the system is up to communicate with the HiPerCam1.

3.3.6 Generate a VxWorks boot file for the HiPerCam1

After installation of the VxWorks cross-development package and the HiPerCam1 BSP (board support package), a VxWorks boot file has to be generated to be downloaded by the HiPerCam1. Therefore, start Tornado and select the 'Configure BSP' command from the **Project** menu. Set the **Board Support Package** to HiPerCam1, confirm with **configure** and then **close** the window. The VxWorks boot file generation is started by the 'VxWorks' command in the **Project/HiPerCam1** menu.

After that the HiPerCam1 can boot via Ethernet from the host system.

3.3.7 Booting

To boot the HiPerCam1 the hex switch on the back panel has to be switched to position '1'. When the HiPerCam1 is powered on it starts booting via network automatically after a countdown of seven seconds. The network boot is protocoled on the terminal by some network initialization messages. At the end of the boot sequence the VxWorks logo appears on the terminal.

At state of delivery the HiPerCam1 is equipped with a stand alone VxWorks in the user Flash EPROM. So generating a VxWorks bootfile is not necessary to test connectivity. Just switch the hex switch on the HiPerCam1 to position '3'. The HiPerCam1 now comes up with the VxWorks logo on the terminal.

For applicational use of this VxWorks a runtime licence is necessary!

3.3.8 Configuration Checklist

The following checklist specifies the necessary configuration parameters for the HiPerCam1 and the host system after Tornado installation to allow an easy connectivity of the HiPerCam1 via network to the host system. The configuration data can be modified by the user but care must be taken for corresponding parameter specifications between the HiPerCam1 and the host system.

Table 12: Checklist

HiPerCam1 boot parameter configuration:		**Your configuration**
host name:	hpchost	
file name:	/tornado/target/config/ hipercam1/vxworks	
inet on ethernet:	195.0.0.201	
host inet:	195.0.0.200	
user:	hipercam1	
ftp password:	403	
Host system installation		
network protocol:	TCP/IP	
network IP address:	195.0.0.200	
host name:	hpchost	
correct hosts table		
VxWorks FTP-server configuration (WIndows 95 only)		
user:	hipercam1	
password:	403	
home directory:	C:\	
User Rights	*	

3.3.9 Creating Boot ROMs

The HiPerCam1 may use either the built-in system EPROM or the built-in user Flash EPROM. The hex switch located on the back panel is used to select the boot EPROM. On position '1' the system EPROM will start the VxWorks monitor. On any other non-reset position the system EPROM jumps into user Flash EPROM. The Flash EPROM can keep a modified VxWorks monitor or stand alone VxWorks including a user application for example. The function sysFileToFlash("fileName", offset) (see in sysLib.c) can be called from VxWorks shell on the target to burn the user Flash EPROM. For that the target shell must have net connection (for file access) to host system. For bootable objects the parameter 'offset' has to be always zero.

To generate a stand-alone VxWorks for the HiPerCam1, the Makefile has to be modified for user Flash EPROM usage. The bootfile is generated by the Tornado cross development using the Shell-Stat-Sym Tbl BSP configuration.

3.4 Troubleshooting

If the HiPerCam1 does not come up, Table 12: 'Checklist' in Section 3.3 'Software Configuration' may help to assure correct system installation.

When the HiPerCam1 does not come up with the monitor program on the terminal, check:

- Hex switch is set to position '1'.
- The upper status LED shows an active CPU.
- Correct power connection to HiPerCam1.
- The power supply voltage of the power supply unit is switched to 12 V.
- Serial cable connection for serial I/O 1
  (ELTEC serial cable V-HPC1-Z005).
- Configuration of terminal (Baud, protocol, etc.)

When the HiPerCam1 does not boot via network, check:

- Check that all related network devices (hubs, repeaters, file server, etc.) are powered up.
- Network connection as shown in Section 3.2 'Connect the HiPerCam1 to the Host'.
- Keep in mind that the 10BaseT cross-over cable is only used for a direct host - HiPerCam1 connection. In conjunction with a hub a standard 10BaseT cable has to be used!
- Check the boot parameter configuration of the HiPerCam1. Boot parameters are listed with the '**p**' command on the ROM monitor.
- Make sure that the configuration of the HiPerCam1 boot parameters is consistent to the parameters on the host. Especially the parameters host name, file name, inet on ethernet, host inet, user and ftp password have to be checked.
- Assure that a VxWorks boot file exists in the configured directory.

- FTP server is started and configured correctly.
- Check hosts table on the host system.
- When a gateway is used, check Ethernet IP address for gateway in HiPerCam1 boot configuration.

4 Software Development

Major requirements for a software development environment are a C/C++ compiler, a source code debugger, and cross-development under Windows 95/NT.

Target operating system is VxWorks: a full real-time OS with multitasking.

Wind River's Tornado development system for VxWorks package fulfills these needs: GNU-C/C++ compiler on PC with source level debugger.

4.1 Operating System

VxWorks as the heart of the run-time system supports a full range of real-time features including fast multitasking and interrupt support. The run-time system is fully scalable, allowing the user to configure VxWorks for the widest range of applications. VxWorks networking facilities include NFS, TCP/IP, SLIP, FTP, TFTP, rlogin, telnet and remote boot via network with the BootP protocol.

4.2 ELTEC Imaging API

All frame grabber-related functions are implemented according to ELTEC PC_EYE *Basic Tool* standard, where applicable. Therefore, the HiPerCam1 supplies the same programming interface known from other ELTEC image processing products like PC_EYE family. Thus, there is no need to access ADC registers or to set acquisition ROI by accessing registers just use the C/C++ ELTEC Imaging API. A detailed library description is supplied with the HiPerCam1 BSP as Windows helpfile.

4.3 Development Flow

Imaging applications for the HiPerCam1 are intended to be developed in C or C++, using the foundation of the ELTEC Imaging API. The hardware implementation details are encapsulated for the user to get easier handling. No assembler programming is required. Compilation of the source code is done on the host computer with the Tornado development system.

Software testing is done by downloading binary code into the HiPerCam1 via Ethernet or serial link and debugging with the source-level remote debugger 'gdb', supplied with Tornado.

When using source level debugger, CPU caches have to be disabled (see BSP makefile).

Finally, the operating system together with user code can be programmed into on-board Flash memory in the HiPerCam1 (monitor and debug kernel reside in a separate EPROM, so that there is no danger of corrupting vital firmware). After that, the HiPerCam1 can start image processing immediately after applying power, without further downloads.

5 Demo Program

To start the demo program delivered with the HiPerCam1 BSP package, read the demo.txt file in directory /tornado/target/src/hipercam1/demo.

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Support Request Form

HiPerCam1 Revision	
HiPerCam version:	
Memory size:	
Hardware revision:	
Serial number:	
BSP revision:	
HiPerCam1 Configuration	
HiPerCam IP address:	
Host IP address:	
User name:	
Ftp password:	
Boot file:	
Host Configuration	
Ethernet IP address:	
VxWorks boot file:	
Tornado development tool revision:	
API software revision:	
Operating system and revision:	
Error Description What must be done to reproduce the error:	
Listing of config.h file	

Send the completed form to:
ELTEC Elektronik AG
Support E2i, Mainz/Germany
Telefax +49 (6131) 918-197
E-Mail: e2i_support@eltec.de

ELTEC Elektronik AG
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D-55129 Mainz

Phone: +49 (0) 6131 918-520
FAX: +49 (0) 6131 918-197
email: e2i_support@eltec.de

TECHNICAL ACTION REQUEST

Date: _____

Customer Name: _____ **Customer Ref. # :** _____

Contact Name: _____ **Department:** _____

Phone Number: _____ **FAX Number:** _____

Severity of Problem: ☐ 1. Critical ☐ 2. Serious ☐ 3. Major ☐ 4. Minor

---

Problem concerns: ☐ Hardware ☐ Software ☐ System ☐ Documentation

Product: _____ **Revision Level:** _____

ELTEC Serial No. (barcode): _____

Operating System: ☐ Windows 95 ☐ Windows NT ☐ Other: _____

System Configuration (Hardware/Software):

Motherboard: _____ BIOS: _____

PCI Slot 1: _____ Product: _____
PCI Slot 2: _____ Product: _____
PCI Slot 3: _____ Product: _____
PCI Slot 4: _____ Product: _____

ISA Slot 1: _____ Product: _____
ISA Slot 2: _____ Product: _____
ISA Slot 3: _____ Product: _____
ISA Slot 4: _____ Product: _____

Please include the Support Request Form Sheet (previous page)!

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101, College Road East
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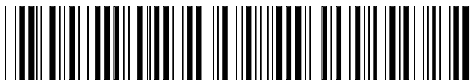

V-HPC.-A991